CLAIMS

What is claimed is:

1   1.   A method for utilizing a plurality of transmitters to determine one or more location

2   characteristics of a body, said plurality of transmitters producing a plurality of RF carrier

3   signals, said method comprising:

4   mounting one or more distributed antennas to said body, each of said one or more

5   distributed antennas having a non-unique phase center;

6   receiving said plurality of RF carrier signals from said plurality of transmitters with

7   said one or more distributed antennas; and

8   determining said one or more location characteristics of said body.

1   2.   The method of Claim 1, wherein said step of determining further comprises utilizing

2   carrier phase measurements for determining said one or more characteristics of said body.

1   3.   The method of Claim 1, wherein said one or more location characteristics comprises

2   a position of said body.

1 4.   The method of Claim 1, wherein said one or more location characteristics comprises

2   an attitude of said body:

1 5.   The method of Claim 1, wherein each of said one or more distributed antennas has a

2   substantially spherical coverage.

1 6.   The method of Claim 1, wherein at least a portion of a view of said one or more

2   transmitters by said one or distributed antennas is blocked by said body.

1 7.   The method of Claim 6, further comprising providing that each of said one or more

2   distributed antennas are circularly constructed with a respective physical origin.

1 8.   The method of Claim 7, further comprising determining a vector from said respective

2   physical origin to a phase center for each of said plurality of transmitters.

1 9.   The method of Claim 1, further comprising determining a distance between each of

2   said plurality of transmitters and each of a plurality of phase centers whereby each phase

3   center corresponds to one of said plurality of transmitters.

1　10.　The method of Claim 1, further comprising obtaining a coarse estimate of a position

2　of said body, and utilizing said coarse estimate for determining a unit vector related to a first

3　position vector of a physical center of said distributed antenna with respect to a reference

4　system and a second position vector between said body and a respective of said plurality of

5　satellites.

1　11.　The method of Claim 10, further comprising utilizing said unit vector for obtaining

2　an improved estimate of a position of said body, and utilizing said improved estimate for

3　iteratively determining said unit vector more accurately.

1　12.　The method of Claim 1, further comprising determining information related to a

2　phase center constellation comprised of a plurality of phase centers such that each phase

3　center in said phase center constellation is related to a respective of said plurality of

4　transmitters.

1　13.　The method of Claim 12, further comprising determining a plurality of vector

2　magnitudes whereby each vector magnitude is related to a vector from a physical center of

3　said distributed antenna to one of said plurality of phase centers.

1   14.   A method for utilizing a plurality of transmitters in a plurality of locations to

2   determine one or more location characteristics of a body, said method comprising:

3   mounting one or more distributed antennas to said body, each of said one or more

4   distributed antennas having a plurality of phase centers with respect to said plurality of

5   locations of said plurality of transmitters; and

6   determining one or more values related to said plurality of phase centers.

1   15.   The method of Claim 14, further comprising:

2   determining one or more values related to a vector to a reference center of said body

3   with respect to a fixed coordinate system.

1   16.   The method of Claim 15, further comprising:

2   determining one or more values related to a position vector from said reference

3   center to an ith satellite.

1   17.   The method of Claim 16, further comprising:

2   determining one or more values related to a vector from said reference center to a

3 phase center related to said ith satellite.

1 18. The method of Claim 17, further comprising:

2 determining an attitude vector for said body.

1 19. The method of Claim 16, further comprising:

2 determining a unit vector for said body from said reference center with respect to an

3 ith satellite.

1 20. The method of Claim 16, further comprising:

2 estimating a unit vector by obtaining an estimate of said position vector.

1 21. The method of Claim 20, further comprising:

2 reducing the error of said estimate of said unit vector by iteration.

1 22. The method of Claim 14, further comprising:

2 measuring a carrier phase from an ith satellite, and adding a correction to said

3 measured carrier phase.

1   23.   The method of Claim 22, wherein said correction is determined utilizing a known

2   attitude of said body.

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2   24.   The method of Claim 22, wherein said correction is determined by making an

3   approximation of said position vector.

1   25.   A system for determining location characteristics of a body utilizing a plurality of

2   spaced apart transmitters, said system comprising:

3   one or more antennas mounted to said body, each of said one or more antennas

4   having a non-unique phase center with respect to said plurality of spaced apart transmitters,

5   said one or more antennas providing a wide angle coverage for maintaining contact with said

6   one or more spaced apart transmitters; and

7   means for determining said location characteristics in response to reception of signals

8   from said spaced apart transmitters by said one or more antennas.

1   26.   The system of Claim 25, wherein said means for determining said location

2   characteristics comprises utilizing one or more equations related to calculating a carrier

3   phase.

1   27.   The system of Claim 25, wherein said means for determining said location

2   characteristics utilizes the following equation:

3

4

5
$$\|v_i\|^2 = \|r_{si} - r_B\|^2 + \|r_{pi}\|^2 - 2\|r_{pi}\|\|r_{si} - r_B\|\cos(\beta_i)$$

6

7   where

8

9
$$\cos(\beta_i) = \sin(\alpha_i) = \sqrt{1 - \left[\frac{(r_{si} - r_B) \bullet \hat{z}_B}{\|r_{si} - r_B\|}\right]^2}$$

10

11   and

12

13
$$\hat{z}_B = \sin(\theta_B)[\hat{x}_e \cos(\phi_B) + \hat{y}_e \sin(\phi_B)] + \hat{z}_e \cos(\theta_B)$$

14

1 28. The system of Claim 25, wherein said means for determining said location

2 characteristics utilizes the following equation:

3

4
$$\|v_t\| = \|r_{st} - r_B\| - r_{pt} \bullet \frac{r_{st} - r_B}{\|r_{st} - r_B\|}$$

1 29. The system of Claim 25, wherein said means for determining said location

2 characteristics utilizes the following equation:

3

4
$$\|v_t\| = \|r_{st} - r_B\| - \|r_{pt}\| \cos(\beta_t)$$

1 30. The system of Claim 25, wherein said means for determining said location

2 characteristics utilizes the following equation:

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4
$$\tilde{\hat{r}}_{stb} \approx \frac{r_{st} - \tilde{r}_b}{\|r_{st} - \tilde{r}_b\|}$$

1 31. The system of Claim 25, wherein said means for determining said location

2   characteristics utilizes the following equation:

3

4
$$\Delta = k\|r_{pi}\|\sin(\xi)$$

1 32. The system of Claim 25, wherein said means for determining said location

2   characteristics utilizes the following equation:

3
$$\Delta_j = \alpha_0 + k\|r_{pi}\|\sin(\xi),\ j = 1,...,N$$

1 33. A radiator system for determining location characteristics of a body utilizing a

2   plurality of spaced apart transmitters, said body having a curved surface, said radiator system

3   comprising:

4   one or more radiators mounted to said curved surface of said body so as to conform

5   to said curved surface, each of said one or more radiators having a non-unique phase center

6   with respect to said plurality of spaced apart transmitters, said one or more antennas

7   providing a wide angle coverage for maintaining contact with said one or more spaced apart

8   transmitters.

1   34.   The radiator system of Claim 33, wherein said one or more radiators comprises a

2   circular ring.

1   35.   The radiator system of Claim 33, wherein said one or more radiators comprises a

2   plurality of circular rings.

1   36.   The radiator system of Claim 33, further comprising means for determining said

2   location characteristics in response to reception of signals from said spaced apart transmitters

3   by said one or more antennas.

1   37.   The radiator system of Claim 33, wherein said means for determining said location

2   characteristics comprises utilizing one or more equations related to a carrier phase.

1   38.   The radiator system of Claim 33, further comprising means for determining an

2   attitude of said body utilizing no more than two antennas wherein said body has three

3   attitude degrees of freedom.

1   39.   The radiator system of Claim 33, further comprising means for determining an

2   attitude of said body utilizing no more than one antenna wherein said body has two attitude

3   degrees of freedom.

1   40.   The radiator system of Claim 33, wherein said one or more radiators maintain contact

2   with said plurality of spaced apart transmitters even when a portion of a view of said

3   one or more antennas to said plurality of spaced apart transmitters is blocked.

1   41.   A method for carrier phase determination of location characteristics utilizing a

2   plurality of spaced apart transmitters, comprising:

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4   mounting one or more antennas to a moveable body positioned among said plurality of

5   spaced apart transmitters such that said antennas maintain contact with each of said plurality

6   of spaced apart antennas as said attitude of said body changes without utilizing RF switches;

7   and

8

9   determining one or more values related to one or phase centers of said one or more antennas.

1   42.   The method of Claim 41, further comprising determining an attitude solution for said

2   body when said body has three attitude degrees of freedom utilizing no more than two

3   antennas.

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1   43.   The method of Claim 41, further comprising determining an attitude solution for said

2   body when said body has two attitude degrees of freedom utilizing no more than one

3   antenna.

1   44.   The method of Claim 41, further comprising providing that said one or more antennas

2   has wide angle coverage for simultaneous contact with said plurality of spaced apart

3   transmitters.